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AN

ESSAY

ON

THE CENTRAL INFLUENCE

OF

MAGNETISM.

BY JOEL ABBOT.

PHILADELPHIA:

PRINTED FOR THE AUTHOR.

1814.

DEDICATION.

TO all promoters of Science, for the benefit of mankind; and for the discovery of that chaste simplicity in the laws of motion, by which nature performs her wonderful operations;

THIS ESSAY

IS RESPECTFULLY INSCRIBED,

BY

THE AUTHOR.

PREFACE.

TO prove the centre of the earth to be the seat of magnetic power and government, I have used no argument but from facts that have been a great while familiar to philosophers. I have chosen this manner, that the opinions here entertained may admit the easiest and fairest scrutiny; for I am sensible of no magnetic effect that cannot be easily explained from the premises.

The illustrations may tend to the establishment of fixed data, from which reasoning on magnetism may be confined: and some properties in magnets are suggested which have not heretofore been considered. The opinions here advanced, I have familiarly expressed to my literary friends for twenty years past.

JOEL ABBOT.

WASHINGTON (Georgia)
October, 1813.

ON MAGNETISM.

THE effects of Magnetism have arrested the attention of philosophers in all ages since the properties of the Loadstone were discovered, and many ingenious theories have been invented to account for magnetic operations. But these wonderful phenomena being governed by a hidden principle, which is beyond the reach of our senses, they are not easily understood.

Nature and Art, however have furnished a number of facts which are the effects of magnetism; and these facts must form the only data from whence we can reason on it with any certainty.

Hence the principle of magnetism can be understood only by its effects, and that reasoning which explains the operations of this principle from all the known effects of it, and is contradicted by none of these, must be near the truth.

The opinions here entertained on the subject of magnetism are consistent with the following

PROPOSITION,

That the center of the Earth is the seat of magnetic power and government, from whence all magnetic influence originates.

In adducing proofs in support of this proposition the following magnetic effects will be examined.

First, the effects of magnetism on soft iron.
Second, ... on the compass needle.
Third, ... on the dipping needle.
Fourth, ... on loadstone and artificial steel bars, rendered magnetic.
Fifth, magnetism communicated to the needle by electricity.

FIRST.

The effects of magnetism on soft iron.

It is philosophical to conclude that all bodies capable of being acted on by the natural power of magnetism, will be more readily impressed with its influence on the direct line of the action of that power, than in any other position. Soft iron is proved by experience to be more susceptible of magnetism than any other body.

Therefore a bar of soft iron will most readily become magnetic when placed in the natural line of magnetic influence; which natural line is vertical.

It was known so long ago as in the sixteenth century that a bar of iron, held perpendicularly, would acquire magnetism, and while in that position exhibit the properties of a magnet, by its lower end attracting the south pole of the needle, and its upper end the north pole. But this virtue is transient, so that if you invert the bar its poles will be changed.

The instant a bar of iron is suspended vertically, it is a magnet. Its lower end is a north pole, and its upper end a south pole. Change the ends any number of times and so soon as one end points centrally, that end is a north pole. In the act of changing them, the magnetism acquired by the position is lost. In a south latitude the lower end of a perpendicular bar of iron is a south pole, and the upper end a north pole.

Here is good evidence that the line of magnetic influence is central. r you place a bar of iron on the meridian, or in any position nearly horizontal, it has no such effect.

A bar of iron remaining a long time in a vertical position may obtain permanent magnetism.

Boerhaave in his Chemistry says, "that a large iron bar suspending a cross of an hundred pounds weight on the top of the church of Aramini, was transmuted into an actual loadstone."

SECOND.

The effects of Magnetism on the Compass Needle.

Magnetism causes the compass needle to point towards the poles of the earth. The poles are the two points on the surface of the earth that are nearest to the centre.

Sir Isaac Newton estimated the polar to the equatorial diameter of the earth, as 229 is to 230; which makes the poles between 17 and 18 miles nearer the centre, than the equator. The late French astronomers Delambre and Mechain, make the difference in the two diameters something less. In their report of the new metrical system of France to the National Institute, they make the difference between the polar and equatorial diameters =23.777 miles, which is probably near the truth. So that by this account, the surface of the earth at the poles is about 12 miles nearer the centre, than at the equator.

From the construction of the compass, the needle is confined in its motions to the plane of the horizon, and will point towards that part of the horizon, which is on the nearest direction to the seat of its governing

power. The power which governs the needle, is at the centre of the earth. The needle therefore, will point towards the poles in obeying the influence of that power. For it is obvious that the needle, which is confined on the plane of the horizon, can point to no direction which inclines so much towards the centre of the earth as when it points to the poles. Consequently, magnetism at the centre of the earth governs the polarity of the needle.

It is observed by all compass makers in north latitudes, that the needle hangs level on the pivot before it is made magnetic; but after it is impressed with magnetism, the north point falls below the level. And in south latitudes, cæteris paribus, the south point falls below the level. To prevent this dip, (if the end disposed to elevate is not left heavier than the other,) a piece of wax or brass wire is put on the elevated end. And as the force which occasions the dip is greater near the poles than near the equator, when the compass is carried from a low to a high latitude, it sometimes becomes necessary to move the wax or wire farther from the pivot, to balance the increased force which draws the dipping end down.

June 30th, 1804, Messrs. Robertson and Sacharoff made an aërostatic voyage from Petersburgh under the sanction of the imperial academy. Among the various instruments they took with them, were a barometer and compass. The aeronauts at an elevation indicated by 22 inches in the mercurial column, noticed that their compass needle was no longer horizontal, the north end being elevated near ten degrees.

This phenomenon is accounted for, only by the doctrine of central magnetism. It is known that the effects of magnetism decrease in relation to distance, in a very great ratio. In this case, the needle was so far

removed from the earth, that it had lost much of the magnetic influence; so that its north end was no longer drawn by the same degree of the central power, that had been applied to it on the surface of the earth; and the superior gravity of the south end being not opposed as before, elevated the north end near ten degrees.

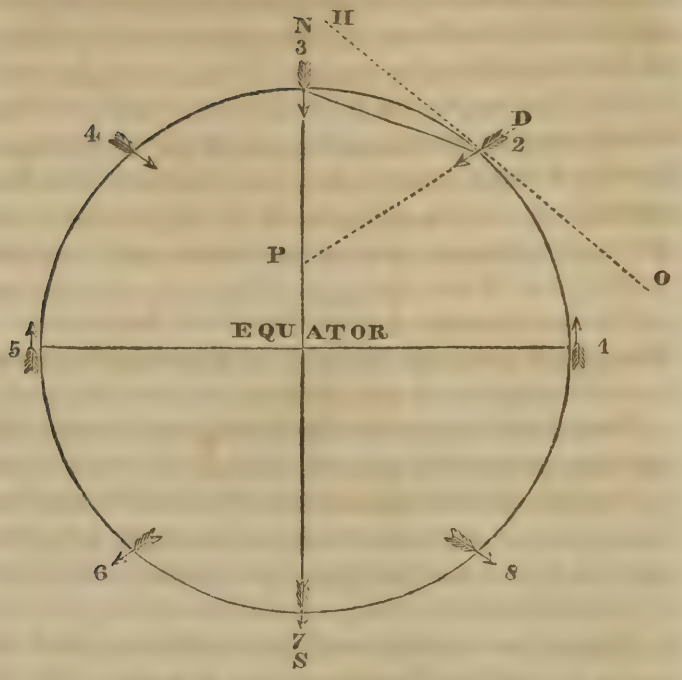
THIRD.

The effects of Magnetism on the Dipping Needle.

The dip of the compass needle led to the invention of the dipping needle; the operations of which bear conclusive evidence of the central power of magnetism. From various observations made at London, (lat. 51° N.) the dipping needle hangs at a medium of 72° below the horizon. In Dobson's edition of the Encyclopædia is found the following observations of the dip in high latitudes.

In lat.	60°	18′	N. the dipping needle hangs				75°	00′ below the horiz.
	70	45	.	.	.	.	77	52
	80	12	.	.	.	.	81	52
	80	27	.	.	.	.	82	2½

The operations of the dipping needle are such, that it makes a greater angle with the horizon continually as it is carried from the equator toward the pole. At the pole it hangs vertical. So that were a dipping needle carried on a meridional circle round the earth through the poles, it would make a complete revolution on its axis.



This diagram represents a meridional circle, and the figures of an arrow at 1, 2, 3, 4, 5, 6, 7, & 8, represent the positions of the dipping needle at 8 places on the circle, viz.—At two places on the equator 1 & 5, 180° distant; at the poles 3 & 7; and at four places on the circle where it intersects the parallel of 51°, in both latitudes, 2, 4, 6, & 8. The bearded points of the arrow mark the N. pole of the needle. Were the dipping needle governed by magnetism at the pole, the dip at London could not be below the chord of an arc from 51° to 90°, which is represented by the line 2, 3, and would make but a small angle with the horizon O H. Whereas the dip in that latitude is 72° below the horizon represented by the line D P, and is within 18° of being central.

Hence the seat of magnetic power appears necessarily to be at the centre, to effect the various operations of the dipping needle.

The dipping needle is so nicely poised on an horizontal axis, as to remain in any situation it may be placed, before it is made magnetic. After it is impressed with magnetism, and placed on the meridian, the north pole will dip in a north latitude, and the south pole in a south latitude.

On the equator, both poles of this instrument are equally attracted by the two polar properties of the central magnet, and it is therefore horizontal. As it is carried from the equator towards the N. pole, the south polar influence over the S. pole of the needle decreases as the instrument recedes from the equator; and in the same proportion does the north polar influence increase, in consequence of gaining a situation nearer the centre.

Were it not for the south polar influence over the south pole of the dipping needle, it would hang perpendicularly in all north latitudes, however situated. For when this instrument is so placed in a N. latitude, that its axis is on the meridian and the needle east and west, it always hangs vertical. In this case, the south polar influence over the S. pole of the needle, acts transversely to the dipping motion; therefore it cannot oppose the central tendency of the N. pole. For this fact, we have the authority of Dr. Larimore, who made great improvements on the dipping needle. He says, "the common dipping needles, to be of use, "must be placed, by some means or other, in such a "manner, as that all their vibrations shall be made in "the true magnetic meridian, north and south, other-"wise they are good for nothing. For if one of them "is placed at right angles across the magnetic line, it

" will stand perpendicularly up and down, in any part " of the world; the least dip therefore is always in " the magnetic line." *Reese's Cyclopædia*, Art. DIPPING NEEDLE.

All the writers and experimenters on magnetism attend to what they call the " true magnetic line," which they say is the line represented by the dipping needle. This cannot be the true magnetic line; for the line indicated by the dipping needle is the effect of one point of the needle being acted on more forcibly than the other; and it is not the effect of only one point being acted on by magnetism.

The dipping needle points out the true magnetic line, when only one end of it can be acted on with effect; in which case it is invariably perpendicular.

FOURTH.

The effect of Magnetism on Loadstone, and artificial Steel Bars rendered Magnetic.

In attending to the phenomena of permanent magnetism, such as is found attached to loadstone and steel, it is proper to state the following corollaries as consequences of the facts already proved.

Corollary 1st.

The great magnetic power at the centre of the earth communicates to all ferruginous bodies, and controuls all the magnetic properties they possess.

Corollary 2d.

The central magnet has poles and an equator analogous to the poles and equator of the earth. Magnetic virtue issuing from it north of the equator, has distinct-

governing qualities, different from that which issues south of the equator; the one governing a north, and the other a south polarity. And all bodies capable of receiving and retaining its influence, possess the properties contained in itself.

The properties in magnets which have excited the attention of philosophers are, first, the directive influence which they receive, that causes them to point towards the poles of the earth—and, second, their attractive power, which disposes them to unite to each other at poles of different names.

These are properties common to loadstone and artificial magnets.

The loadstone is a quality of iron ore of a peculiar texture, fitted to receive magnetic impressions from the great natural magnet of the earth;—and steel bars receive the same impressions by artificial means.

The directive influence of magnets has been explained under the heads of the compass needle and dipping needle. In regard to the attraction between the north and south poles of different magnets, it is only necessary to exhibit the analogy that exists between this fact and the common effects of the natural power of magnetism.

It is no more our object to assign a *reason* for the attractive power of magnets, than why the laws of gravitation exist.

Example.

Were perpendicular bars of iron to stand on the ends of each other nearly in contact, and extend in a line from one side of the earth to the other through the centre, (for instance, from latitude 34° N. to 34° S.) each bar would be a distinct magnet, while they re-

mained in that situation. The N. pole of every bar would point to the S. pole of the bar next to it, and these would attract each other throughout the whole line. Consequently these bars, which are magnets only by their being media for magnetism from the centre outwards, the poles given to them are in the same position in relation to each other, which permanent magnets strive to obtain; i. e. with a north and south pole together.

This example is hypothetical, only by conceiving known facts to be multiplied beyond our power to examine. But eight, ten, or twenty bars, or as many as can be tried, exhibit the phenomenon stated. Therefore it is reasonable to admit the same effects to take place, were it possible to continue the experiment to the centre of the earth.

In this conceived example of a line of bars extending through the centre of the earth, it is to be understood that the ends of the bars towards the centre, in the northern hemisphere, would be N. poles; and those towards the centre in the southern hemisphere, S. poles. It is therefore consistent with all the known effects of magnetism, to allow, that there is the same difference in the north and south polarity of the great central power of magnetism, which is exhibited in the loadstone and artificial steel magnet: and that loadstone, artificial steel magnets, and the evanescent magnetism of soft iron, have a sameness of properties.

Hence there is the same [and no other] difficulty in assigning the reason why permanent magnets attract each other at poles of different names, that there is in accounting for the same effect in vertical bars of iron; for they are the identical effects of the same cause.

The directive and attractive powers which are exhibited in magnets, differ in only one thing, viz. the di-

rective power is the effect of attraction from the polar influence of the central magnet. And the attractive power is the effect of magnetism adhering to magnetic bodies, which disposes them to attract each other.

FIFTH.

Magnetism communicated to the Needle by Electricity.

Magnetism becomes attached to steel and iron by a variety of means. Instances have been met with of electricity impressing a very strong magnetic power on files and other pieces of steel, when struck with lightning. And indeed the same phenomenon may be exhibited by the aid of a common electrical machine.

Cavallo, in his Essay on Electricity, says, "when "the charge of ten, eight, or even a less number of "square feet of coated glass is sent through a fine "sewing needle, it will give it polarity, so that it will "traverse when laid on water. It is remarkable, that "if the needle be struck lying east and west, that end "which is entered by the shock, will afterwards point "north; but if the needle be struck lying north and "south, that end of it which lay towards the north, "will in any case point north; and the needle will "acquire a stronger virtue in this, than in the former "case. Lastly, if the needle is set perpendicular to "the horizon, and the electric shock is given to either "point of it, afterwards the lower extremity of the "needle will point north."

These facts, like all other magnetic phenomena, appear to bear strong evidence of the central power of magnetism, and that the true magnetic line is vertical. There is no similarity between the matter of electrici-

ty and magnetism. When a magnet is made by electricity, it serves to attach the pervading principles of magnetism to steel. In which case, magnetism is not created de novo, any more than is fire when produced by friction.

The three facts stated by Cavallo, are,

1st. That electricity applied to the needle lying east and west, gives a north polarity to the end in which it enters. In this instance both ends of the needle are equi-distant from the centre, and either of them disposed to receive a north polarity in a north latitude: therefore the polarity given is probably owing to the motion of electricity.

2d. That electricity applied to a needle lying north and south, the north end makes a north pole, whether the electricity enters at one end or the other. This effect is produced in consequence of the north end being inclined towards the centre; and the virtue imparted to it is stronger than in the first case, for that very reason.

And 3d. That electricity applied to a perpendicular needle, at either end, the lower extremity of it is made a north pole. While the needle is in this position, it is in the true magnetic line, in which the magnetic power passes direct from the centre of the earth, and the principle is applied to it in the same manner it is to perpendicular soft iron bars.

These experiments were made in a north latitude, in which hemisphere a north polar magnetism passes from the centre, and impresses a north pole where it enters the bodies that are capable of retaining its principle. Were these experiments made in a south latitude, these points which are here north poles, would be there south poles.

Electricity renders steel magnetic, probably from a

momentary change which it produces in the texture of the steel, that favours a reception of the pervading principle of magnetism which is then present. For the principle of magnetism may be considered universally present on the earth, but is required to be located to some body, before it can be made sensible to us.

The Variation of the Needle.

The variation of the compass needle, sometimes to the east and sometimes to the west of north, is a subject which has engaged the attention of many eminent philosophers in every age since the loadstone was discovered. Among these were Doctor Halley, Messrs. Whiston, Euler, Cavallo, Churchman, and many others. Some of these gentlemen have endeavoured to establish general theories of magnetism on the individual effect of the variation of the needle; and each of them have been equally successful.

Iron, the most universal of all metals, is the only one that is much susceptible of magnetism. It is found in all countries and in all depths of the earth heretofore explored. All large masses of iron ore possess more or less of magnetism, and some of it of a peculiar texture constitute the real loadstone.

These ores not only possess different degrees of magnetism which they acquire by time, but are actually generated, and grow.

The bog ore, particularly, is known to have been produced in certain marshes in England with a sensible increase.* All other iron ores also more than probably grow, or are generated by a peculiar combination of elementary matter. The loadstone was once a mere ore of iron, but being of suitable texture, be-

* Botanic Garden, Canto 2d.

came magnetic by lying a great while in the same position. It was not created a magnet when the hills were moulded, but obtained its properties in process of time from the great central power of magnetism. And large beds of iron ore may, during the present century, have no loadstone in them, but in some succeeding century a great deal of the ore may become actual loadstone, with great attractive power.

Hence, the magnetic attractive influence of iron ores and loadstone, being not only variant, but new bodies of both being produced in new situations by the process of time and elementary composition; the needle, when within attractive distance of these, will vary from the true north and south points, if both the attracting body and needle are not on the same meridian. And the variation will not continue to be the same in the same place, when the attractive influence is diminished, or when it acts on the needle from a different quarter by the formation of new bodies of attractive power.

Great variations of the needle may be expected in all countries abounding much in iron; as is the case in England, and on the western parts of the European continent, where the variation has been progressing for several centuries from the east towards the west, which is more than probably owing to new bodies of iron ore changed gradually into loadstone, west of those bodies which had formerly attracted the needle to the east.

Therefore, it is rationally concluded, that this phenomenon is not occasioned by the *direct* operation of the great magnetic principle from its original source; but is owing to the indirect influence of magnetism incidentally attached to ferruginous substances, irregularly distributed through the earth.

Speculations on the Figure of the great Central Magnet, and its other Properties besides Polarity.

The idea of a central magnet is necessarily connected with body, or substance, which must have some figure or shape. It is not presumable that the central magnet is a body of ponderous matter like loadstone, but that it is a body consisting purely of such principles as are found imparted to substances rendered magnetic. It consists in that principle of matter, which makes a magnet differ from all other things.

The magnetic principle acts as freely in vacuo as in the open air, and through the hardest substances as if nothing intervened. It is therefore an extremely subtile fluid. And "Mr. Whiston found from repeated "trials on large needles, that after the touch, they "weighed less than before. One of $4584\frac{1}{8}$ grains lost "$2\frac{5}{8}$ grains by the touch; and another of 65726 grains "weight, no less than 14 grains." *Chambers' Dictionary*, Art. *Magnetism, laws of.*

Hence it appears that the magnetic principle consists not only of the most perfect tenuity and subtility, but that a distinguishing characteristic of it, is levity.

And if Mr. Whiston's statement of facts is good evidence, we may suppose one quality of magnetism is absolute or positive levity; which is the only instance of such a quality of matter existing in nature. If it opposes the gravitating tendency of steel, the opposing force must be applied inversely to the centre of gravity; and this also may be advanced to support the proposition of the centrality of magnetism.

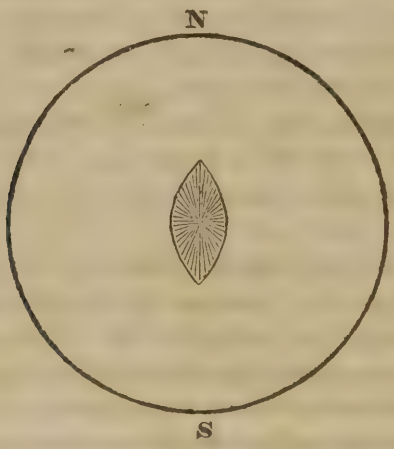
If magnetism acts freely in vacuo and through the hardest substances, and when attached to steel, makes the steel lighter, it is probably a body of the most perfect tenuity and levity in nature; and does not require

the absence of other bodies, for it to occupy any place.

Then from these premises, we come to a rational conjecture of the figure which this body occupies.

"If a glass globe be filled with water and oil, and "whirled round on its axis, the centrifugal power will "carry the heavier fluid to the circumference, and the "lighter will, in consequence, be found about the "axis."

In this way, the rapid diurnal revolution of the earth on its axis, occasions the light matter of magnetism to hover round the centre, and taper along the axis towards the poles. Consequently the body of magnetism at the centre of the earth must be nearly in the form represented in the following diagram.



This central body of magnetism having a greater polar, than equatorial extension, attracts bodies more powerfully on the surface near the poles of the earth, than near the equator; which is a reason additional to what has been advanced, why the needle points to the poles.

The great advantage derived to mankind from the

polarity of magnets, and the conspicuous attractive powers at their poles, having absorbed so much philosophical attention, may be a reason why no other properties in magnetism have been sought for.

But that there are other important properties in magnetism, I have no doubt. It is no more strange that the great magnet at the centre of the earth should have distinct attractive powers on its meridional surface, than that such should be at its poles.

If neither the polar nor meridional properties in magnetism had yet been discovered, the one would be as readily admitted in argument as the other, and with as good reason.

By mechanical ingenuity in shaping and suspending the needle, and impressing it properly with magnetism, it is attracted to the poles of the world, and obeys that attraction. By the same ingenuity in shaping and suspending a body of steel in the form of the central magnet, as described in the diagram, and impressing it properly with magnetism, it will be attracted to the meridian over which it lies, and obey that attraction.

Innumerable meridional lines may be conceived on the central magnet, from pole to pole, coincident with the meridional lines conceived on the earth. Consequently under every meridian on the surface of the earth, there is a stationary corresponding meridian on the central magnet, from whence a local meridional attraction operates on all magnetic bodies. As the polar attractive power of the central magnet is transferred to all artificial magnets, so also is the meridional attractive power transferred to them. Thus in artificial magnets we have all the properties of the great central power of magnetism in miniature.

Then if magnets are made of such a form as to ena-

ble them to yield to the meridional influence transferred to them, they will obey the government which attracts them east and west, as the needle obeys the government which attracts it north and south.

Turn a piece of steel an inch and a half in diameter and three inches long, tapering equally from the middle each way to a point at the ends, harden it, and if it will lie on mercury with any side down, it is well made. Then give it a strong magnetic impression, draw longitude lines on it, and float it on mercury. Now it will lie with but a certain side down, and the poles will be north and south.

Fix a graduated circular plate of ivory perpendicular to its equator, with a perpendicular index to show the meridian, and this instrument will point out the longitude of any place it is in.

By the meridional attractive power attached to it, the meridional lines on it will turn east, when this instrument is carried west; and if carried round the earth, it will have turned once on its axis.

A magnet in the form of a perfect globe, with its poles passing directly through the centre, would be a more perfect instrument, as it would very nearly show the latitude as well as longitude; but from the difficulty of making such a body with the magnetic poles going through its centre of gravity, I have preferred recommending the foregoing form of a magnet, as being easily constructed with accuracy.

JOEL ABBOT.

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